Traffic Study Report

Nonantum Road Improvements

Newton, Massachusetts
& Watertown, Massachusetts

Prepared for the

dcr | *department of* Conservation and Recreation

Prepared by

Fay, Spofford & Thorndike, LLC

June 2006

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1. INTRODUCTION

1.1 OVERVIEW

Under a contract with the Department of Conservation and Recreation (DCR), Fay, Spofford & Thorndike, LLC, (FST) has been asked to provide traffic engineering services to evaluate alternatives to improve public safety along Nonantum Road and its adjacent parkland in the City of Newton, and the Town of Watertown, Massachusetts. The extent of the study encompasses roadway and parkland improvements along a 5,500-foot length of Nonantum Road from the Newton/Boston city line to Galen Street in Watertown. Major design elements to be evaluated as part of this study include:

- Feasibility of eliminating one eastbound travel lane on Nonantum Road;
- Opportunity to increase green space and widen multi-use path adjacent to the river;
- Need for signalization at the intersection of Nonantum Road and Charlesbank Road.

This report marks the completion of the conceptual phase of this study. The intersections along Nonantum Road – at Charlesbank Road, Maple Street, Water Street, and at Galen Street – have been evaluated in terms of traffic operations and accident history. Based on this evaluation of existing conditions, improvements are recommended which respond to the operational and safety deficiencies. Improvements include:

- Reducing the roadway cross-section on Nonantum Road to provide a single travel lane in each direction with left turn lanes at major intersections;
- Minor geometric improvements at study area intersections;
- Providing landscape enhancements to separate the recreational path from the parkway, increasing pedestrian safety.

2. EXISTING CONDITIONS

2.1 GEOMETRICS

Nonantum Road is a parkway owned and controlled by the DCR. The parkway generally runs in an east/west direction along the southern bank of the Charles River and is illustrated in Figure 1. Within the study area Nonantum Road is intersected at three locations by local residential roadways (Charlesbank Road, Maple Street, and Water Street) that are controlled by stop signs, and ends at a signalized intersection at Galen Street in Watertown. Pavement width on Nonantum Road throughout the study area remains fairly consistent at 40 feet in width and is striped for two 10-foot lanes in each direction. The edge of roadway is delineated by a mix of granite curb, bituminous concrete curb or edge of pavement with no curb.

A bituminous concrete sidewalk/recreational path varying in width from 5 to 8 feet parallels the roadway on its north side along the banks of the Charles River. From the Newton/Boston city Line to Charlesbank Road, the path is separated from the westbound roadway by a five-foot planting strip with trees at about 50-foot intervals and roadway light poles at about 100-foot intervals. Beyond Charlesbank Road, towards Galen Street, there is no physical separation of the path from the westbound roadway apart from granite curbing, save for a relatively short length of guardrail at a river bend between Charlesbank Road and Maple Street. There are no pedestrian facilities on the southerly eastbound side of Nonantum Road.

The posted speed limit on Nonantum Road is 40 mph. The roadway is designated for pleasure vehicles only, to the exclusion of trucks and buses; however, while the eastbound side is signed “NO TRUCKS OR BUSES,” there is no similar signage on the westbound side.

In general, both the existing horizontal and vertical alignment of Nonantum Road is adequate for the posted speed limit and is consistent with what one would expect for a parkway design. However, it is noted that there is short reverse curve in the roadway through the intersection of Maple Street to carry Nontantum Road past an existing headwall.

Charlesbank Road, Maple Street, and the westerly leg of Water Street all intersect with Nonantum Road at acute angles, requiring operators to either enter Nonantum Road blindly while watching for traffic over their left shoulders, or be unaware of approaching traffic from behind while watching the road ahead. The skewed approaches of the intersecting streets also result in wide intersections that encourage drivers turning left from Nonantum Road to take a wide turn at higher than desired speeds. This is particularly a concern at the intersection of Charlesbank Road where the combination of the skewed intersection and horizontal curvature of Nonantum Road creates that appearance of a through movement rather than a left turn onto Charlesbank Road.

Sight distances for traffic entering from both Maple Street and the westerly leg of Water Street are particularly constrained by combinations of geometry, terrain, and the built environment. Likewise, vehicles traveling eastbound on Nonantum Road, particularly vehicles traveling in the right lane, have similar constraints on stopping sight distance when approaching each of the intersections, and often are forced to either shift quickly to the left lane or decelerate

Scale: 1" = 1000'

Nonantum Road Improvements
Newton/Watertown, MA

Project Location

Figure 1

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rapidly to avoid rear-ending a slower entering vehicle. Field observations also showed traffic on Charlesbank Road experiencing long delays entering at Nonantum Road at peak hours due to high volumes of eastbound traffic.

2.2 DATA COLLECTION AND TRAFFIC PROJECTIONS

In order to evaluate traffic operating conditions and conduct traffic signal warrant analyses at the study area intersections along Nonantum Road, a traffic count program was conducted during the week of March 20, 2006. This traffic count program consisted of both automatic traffic recorder (ATRs) and manual turning-movement counts (TMCs).

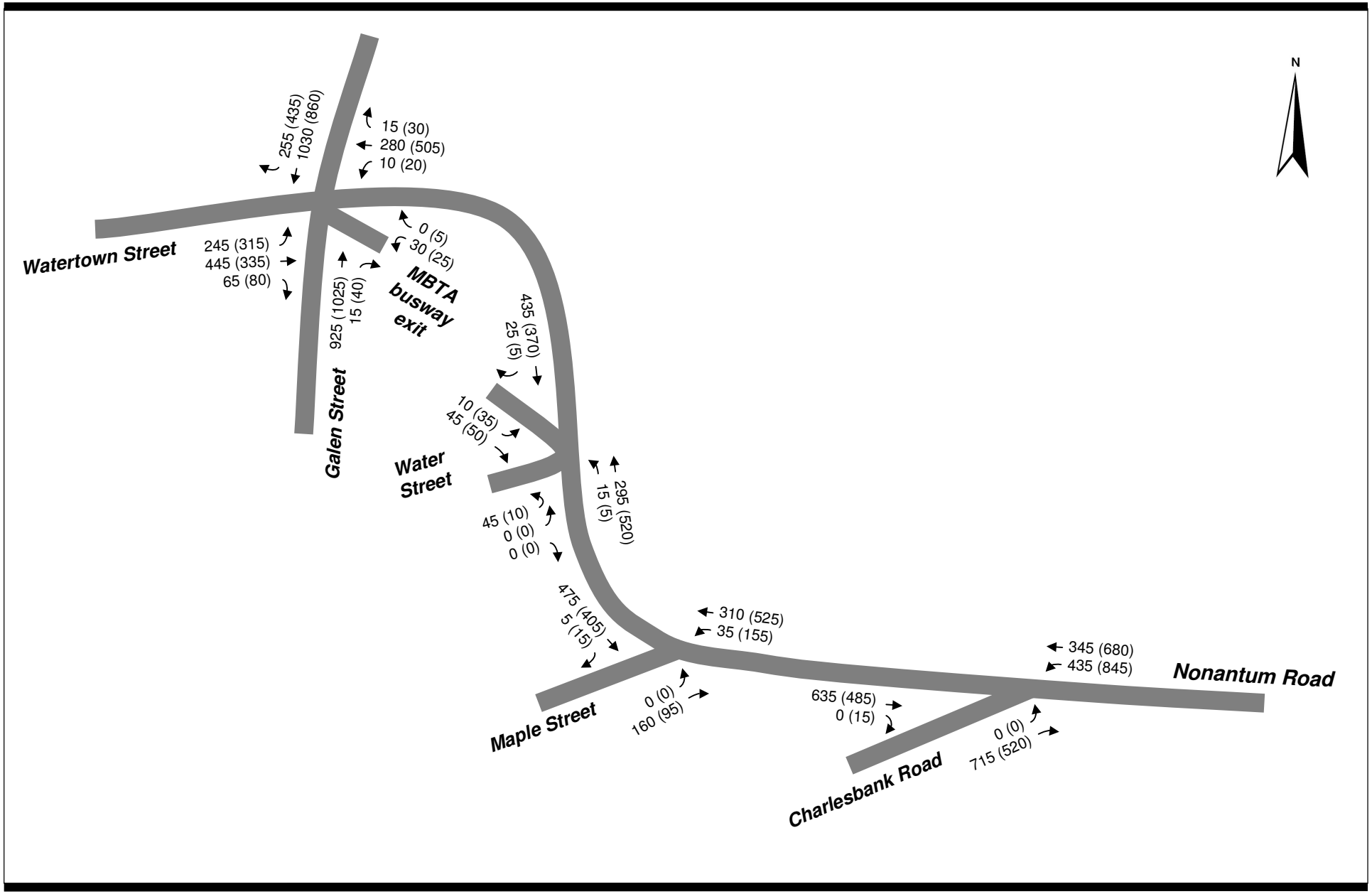
ATRs were taken at five locations: three along Nonantum Road, one on Maple Street, and one on Charlesbank Road. ATRs were taken for a minimum of forty-eight hours at all locations. Manual turning movement counts were taken for two hours during the AM peak period (7-9 AM), and two hours during the PM peak periodr (4-6 PM). From the data, peak-hour traffic volumes for the study-area intersections were determined. These volumes are shown in Figure 2.

Table 1 presents a summary of existing traffic volumes recorded as part of the traffic count program. As the information in the Table 1 indicates, Nonantum carries between 10,000 and 25,000 vehicles on a typical weekday. The higher volumes were found on the section of Nonantum Road east of the intersection with Charlesbank Road where the turning movements counts also indicated heavy turning volume from Charlesbank Road entering Nonantum Road and heading east.

Table 1
2006 Existing Traffic Volumes

Location	ADT	AM Peak	PM Peak
Nonantum Rd, West of Maple St.	10,100	820	920
Nonantum Rd, East of Maple St.	11,800	960	1,120
Nonantum Rd, East of Charlesbank	25,100	2,050	2,340
Maple Street	2,400	190	310
Charlesbank Road	14,200	1,160	1,350

In order to evaluate the ability of Nonantum Road and the intersections along the corridor to handle anticipated traffic growth, it was necessary to project future traffic volumes. A ten-year forecast horizon was selected for this study to account for a reasonable level of growth and provide a meaningful measure for comparing improvement alternatives. Following from conversations with planners from both the City of Newton and the Town of Watertown, an average annual growth rate of 1.0% per year was used. Projected 2016 peak-hour traffic volumes for the study-area intersections are shown in Figure 3.



Schematic Diagram: Not to Scale

Nonantum Road Improvements
City of Newton and Town of Watertown, Massachusetts

Figure 2

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2006 Existing AM (PM)
Peak Hour Traffic Volumes

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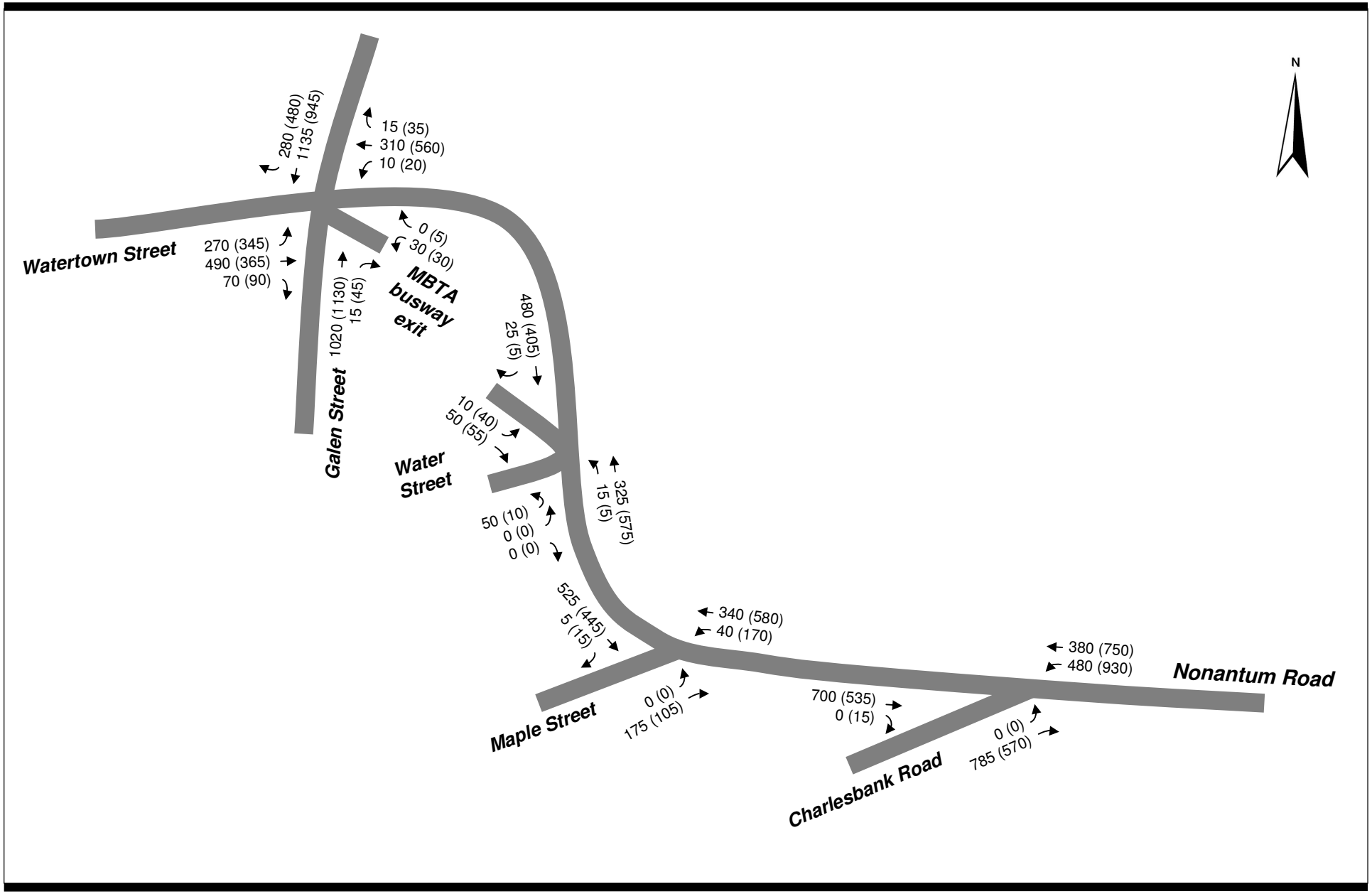

Schematic Diagram: Not to Scale

Nonantum Road Improvements
City of Newton and Town of Watertown, Massachusetts

Figure 3

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2016 Projected AM (PM)
Peak Hour Traffic Volumes

dcr

2.3 TRAFFIC OPERATIONS

Level of Service

Level of Service (LOS) is an expression of the quality of flow of traffic. LOS is a commonly used and accepted measure of the effectiveness of peak-hour traffic operating conditions. It takes into account automobile and truck volumes, roadway width, speed, grade, parking restrictions, pedestrian activity and traffic control devices.

LOS is designated in a range from Level "A", which is the optimal condition where roadway operations are at their best, to Level "F" which indicates traffic jam conditions. Levels "A" through "D" are typically associated with acceptable levels of peak hour traffic operations. At level "E", the ratio of the approach volume to capacity, or v/c ratio, of an intersection is between 90 and 100 percent of its theoretical capacity. Traffic congestion is considered to be unacceptable at Level of Service "E" or "F".

All capacity analysis for the study area intersections along Nonantum Road were performed in accordance with the methodologies set forth in the 2000 Highway Capacity Manual. LOS at signalized and unsignalized intersections are based on estimates of delay per vehicle. Table 2 presents a summary of the level of service criteria for unsignalized and signalized intersections.

Table 2
Intersection Level of Service Criteria

Level of Service	Unsignalized Delay (sec/veh.)	Signalized Delay (sec/veh)
A	≤10	≤10
B	>10 to 15	>10 to 20
C	>15 to 25	>20 to 35
D	>25 to 35	>35 to 55
E	>35 to 50	>55 to 80
F	>50	>80

Source: Highway Capacity Manual, 2000

Table 3
2006 Existing Levels of Service (LOS)

Movement	AM Peak			PM Peak		
	Delay[1]	LOS	Queue[2]	Delay	LOS	Queue
Nonantum Road at Charlesbank Road (unsignalized)						
Nonantum WB Lt	12.7	B	74	30.4	D	331
Charlesbank NB Lt/Rt	107.7	F	617	26.9	D	205
Nonantum Road at Maple Street (unsignalized)						
Nonantum WB Lt	2.4	A	3	5.1	A	14
Maple NB Lt/Rt	11.9	B	31	10.7	B	14
Nonantum Road at Water Street (unsignalized)						
Nonantum WB Lt	1.2	A	1	0.3	A	0
Water NB Lt/Rt	11.2	B	9	13.8	B	20
Nonantum Road at Galen Street (signalized)						
Watertown EB Lt/Th	37.6	D	530	74.7	E	512
Nonantum WB Lt/Th/Rt	37.2	D	241	115.1	F	521
Galen NB Th/Rt	34.3	D	384	42.5	D	488
Galen SB Th	42.6	D	468	31.5	C	359
Galen SB Rt	16.9	B	74	19.1	B	138
MBTA Drive	67.0	E	56	67.8	E	54
Overall	**36.9**	**D**		**55.2**	**E**	

1. Control Delay in seconds per vehicle
2. 95th percentile queue in feet per lane

Table 3 presents a summary of existing traffic operating conditions along Nonantum Road within the study area. As the results indicate, existing levels of service are generally acceptable with the exception of a few movements. The most notable movement experiencing high delays is the right turn from Charlesbank Road onto Nonantum Road during the morning peak hour. This condition will only get worse as traffic volumes continue to grow as shown in the 2016 No-Build levels of service summary presented in Table 4.

Table 4
2016 No-Build Levels of Service (LOS)

Movement	AM Peak Delay[1]	AM Peak LOS	AM Peak Queue[2]	PM Peak Delay	PM Peak LOS	PM Peak Queue
Nonantum Road at Charlesbank Road (unsignalized)						
Nonantum WB Lt	14.8	B	100	61.0	F	550
Charlesbank NB Lt/Rt	179.3	F	888	41.3	E	302
Nonantum Road at Maple Street (unsignalized)						
Nonantum WB Lt	2.6	A	4	5.4	A	17
Maple NB Lt/Rt	12.6	B	37	11.1	B	16
Nonantum Road at Water Street (unsignalized)						
Nonantum WB Lt	1.2	A	1	0.3	A	0
Water NB Lt/Rt	11.6	B	10	15.2	C	26
Nonantum Road at Galen Street (signalized)						
Watertown EB Lt/Th	59.7	E	617	259.3	F	585
Nonantum WB Lt/Th/Rt	43.7	D	274	359.0	F	583
Galen NB Th/Rt	31.9	C	438	39.9	D	581
Galen SB Th	40.5	D	542	28.7	C	416
Galen SB Rt	14.8	B	83	17.0	B	172
MBTA Drive	67.0	E	56	58.9	E	60
Overall	**41.3**	**D**		**128.6**	**F**	

1. Control Delay in seconds per vehicle
2. 95th percentile queue in feet per lane

Due to the high volume of traffic presently traveling eastbound on Nonantum Road during peak hours, there are an insufficient number of safe gaps to accommodate traffic entering from Charlesbank Road. This results in significant delays and vehicle queues on Charlesbank Road and creates situations where drivers tend to accept less than desirable gaps rather than sit at the approach for an extended period of time. Drivers "forcing" their way onto Nonantum Road impact the movement of traffic on this roadway, producing congestion and increasing the potential for accidents. Continued growth in traffic demands will further decrease the number of acceptable gaps for turning traffic at the intersection, worsening operating conditions.

2.4 ACCIDENT HISTORY

In addition to reviewing traffic operating conditions within the study area, FST also investigated recent accident trends along Nonantum Road. As part of this effort, the accident history for the study-area intersections of Charlesbank Road, Maple Street, Water Street, and Galen Street with Nonantum Road was investigated for the three-year period of 2002, 2003 and 2004. Accident records for Nonantum Road were compiled from the MassHighway database for these three years. Table 5 summarizes the accidents occurring on Nonantum Road over this three-year period.

By far the greatest number of accidents was reported at the intersection of Charlesbank Road with Nonantum Road, where 46 incidents occurred over the three years, for an average of more than 15 per year. Over half the accidents at this intersection during this time period were rear-end accidents, 75% of which involved vehicles on Nonantum Road. This pattern suggests that vehicles either slowing down or coming to a stop on Nonantum Road to avoid a collision with traffic turning at Charlesbank Road are instead being struck by the vehicle traveling behind. Conflicts with turning traffic at Charlesbank Road can be attributed to the limited number of gaps available for vehicles to make these movements and the geometry of the intersection that results from the skewed approach angle of Charlesbank Road.

Although the number of accidents alone is important, the actual exposure or potential for an individual driver being involved in an accident is reflected in the crash rate. Using MassHighway's Crash Rate Worksheet, the intersection of Charlesbank Road with Nonantum Road was found to have 1.64 accidents for every million vehicles entering the intersection. This rate is almost three times higher than the average crash rate of 0.63 for unsignalized intersections in MassHighway's District 4. The intersection of Maple Street with Nonantum Road also experienced a crash rate, 0.68, higher than the district average crash rate for unsignalized intersections.

Table 5
Accident Summary

Location	Total	Accident Type						Injuries
		Angle	Head-on	Rear-end	Sideswipe	Single veh/ Fixed object	Non-specified	
Nonantum Road at Charlesbank Road								
2002	21	4	5	10	0	0	2	14
2003	14	1	0	13	0	0	0	5
2004	11	3	1	4	0	1	2	6
	46	8	6	27	0	1	4	25
Nonantum Road at Maple Street								
2002	5	2	0	3	0	0	0	2
2003	2	1	0	0	0	1	0	2
2004	3	1	1	0	0	1	0	1
	10	4	1	3	0	2	0	5
Nonantum Road at Water Street								
2002	3	1	1	0	0	1	0	3
2003	2	0	0	0	0	1	1	1
2004	1	0	0	0	0	1	0	0
	6	1	1	0	0	3	1	4
Nonantum Road at Galen Street								
2002	9	2	1	3	1	2	0	5
2003	5	1	0	2	1	1	0	4
2004	5	2	0	1	0	0	2	5
	19	5	1	6	0	3	2	14
Nonantum Road at indeterminate locations								
2002	1	1	0	0	0	0	0	0
2003	2	2	0	0	0	0	0	1
2004	3	0	0	2	0	1	0	1
	6	3	0	2	0	1	0	2
Total	87	21	9	38	2	10	7	50

3. IMPROVEMENT ALTERNATIVES

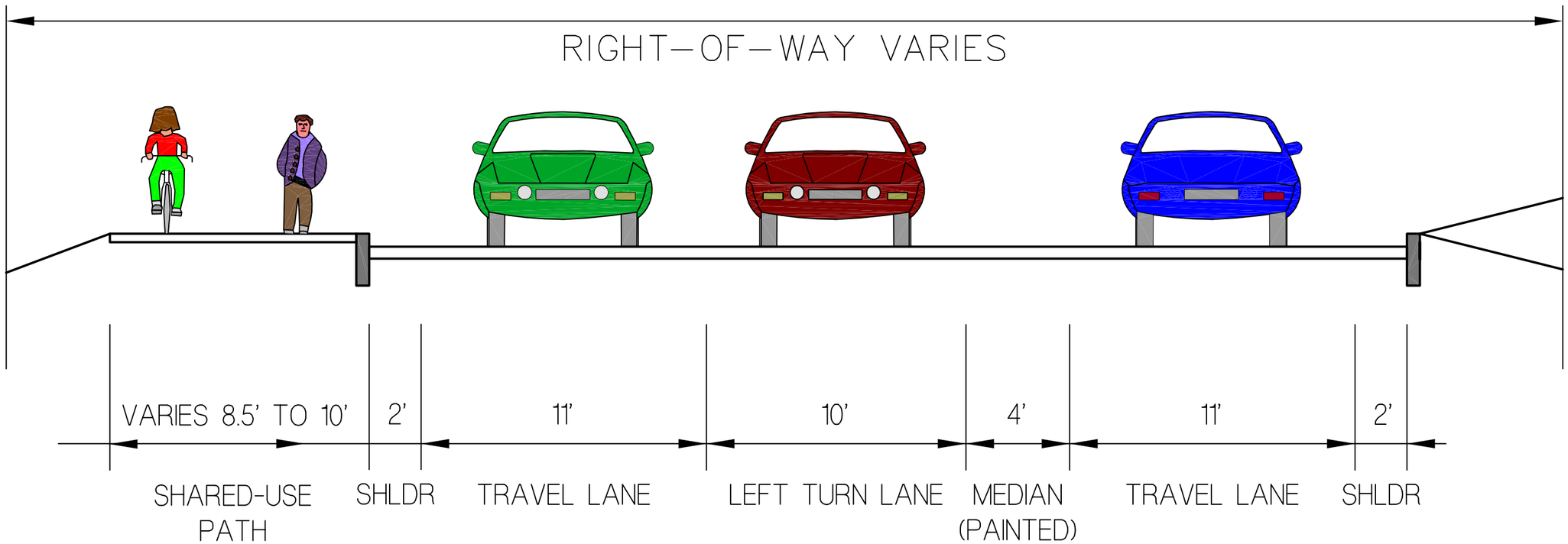
3.1 ROADWAY CROSS-SECTION

Based on a review of the peak-hour traffic volumes and operational analyses previously presented, it was determined that Nonantum Road could reasonably accommodate traffic demands with a single travel lane in each direction within the study area. At the intersections in the study area, this cross-section would be modified to provide an exclusive left-turn lane on Nonantum Road westbound. This ability to reduce the number of lanes provides a unique opportunity to improve safety on Nonantum Road while enhancing existing pedestrian and bicycle accommodations. In essence, roadway lane width can be exchanged for improved alignment, turning lanes, and wider sidewalks with grassed separations. In addition, the intersections with Nonantum Road could be modified within the existing pavement areas to better define the functional area of each intersection and to realign the approaches to improve sight distance. In order to implement the revised roadway cross-section, two alternatives were considered.

Alternative 1 involves restriping Nonantum Road within the existing 40-foot paved width from curb to curb. As shown in Figure 4, the proposed cross-section would consist of two 11-foot travel lanes with 2-foot shoulders and a 10-foot left-turn lane at intersections. Figures 5 through 7 illustrate the application of this typical section in plan view. Either a painted or flush median would be incorporated in the cross-section to offer separation between eastbound and westbound traffic. This median would vary in width from 4 feet at the intersections to a maximum of 14 feet where there is no left-turn lane. The curb line and sidewalk along the northerly side of the roadway would remain as it exists today. However, the pavement would be re-striped to improve the meandering and unsafe character of the travel lanes, particularly through the intersection with Maple Street. The existing 8-foot sidewalks would have to be widened in some areas to provide room for guardrail and lighting where necessary and consistent width for a shared-use path.

In addition, Alternative 1 presents one option for realigning the Maple Street intersection to form a more perpendicular approach and consolidate access points to the adjacent parking area and businesses. Similar improvements are illustrated at the intersection of Charlesbank Road where the approach has been religned slightly and a divisional island provided. Approaching Charlesbank Road, the two existing westbound lanes are retained on Nontanum Road with the left lane designated for left turns only. A single lane is provide on Nonantum Road eastbound leaving the intersection of Charlesbank Road which would transition to match the existing cross-section approximately 1,000 feet to the east.

The estimated cost for construction of this alternative is $300,000, including resetting the northern curb, reconstructing the sidewalk, and providing a painted median. Including a flush rather than painted median increases the estimate cost by approximately another $300,000 to a total of $600,000.



Schematic Diagram: Not to Scale

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Nonantum Road Improvements
City of Newton and Town of Watertown, Massachusetts
Alternative 1
Typical Section

Figure 4

dcr

Insert Figure 5

Insert Figure 6

Insert Figure 7

A second alternative considered for reducing the number of travel lanes actually involves reducing the paved width of Nonantum Road. Figures 8 and 9 present the typical cross-sections on Nonantum Road under Alternative 2. The conceptual plan for this alternative is illustrated on Figures 10 through 12. Under this concept, the curb to curb width of the roadway would be reduced from 40 feet to 30 feet, which would accommodate 11-foot travel lanes with 2-foot shoulders in each direction and a 4 foot painted/flush median.

The realignment of Nonantum Road would take advantage of the available width to create a new edge line to define a straighter alignment that would prevent travel into the opposing lane. In addition, the reduced cross-section would allow for the implementation of a 10-foot shared multi-use path adjacent to the river, which would be separated from the roadway by either a grass or landscaped strip. The curb-to-curb width of the roadway would be widened from 30 to 36 feet in order to provide an exclusive left-turn lane at intersections in the corridor (see Figure 9).

Similar to Alternative 1, minor geometric improvements are made to intersections along the corridor to reduce the skewed angle of intersections. A second option for the transition between four and two lane sections east of Charlesbank Road is presented on these concept plans. Approaching Charlesbank Road, the two existing westbound lanes are merged into to a single lane prior to the introduction of an exclusive left turn lane onto Charlesbank Road. East of the intersection a single lane is provided for the eastbound through movement with the right turn from Charlesbank Road entering a second eastbound lane.

The estimated cost of construction for Alternative 2 is $560,000, including construction of the new multi-use path and a painted median. Similar to Alternative 1, providing a flush rather than painted median would increase the cost of the project by $300,000 to a total of approximately $860,000.

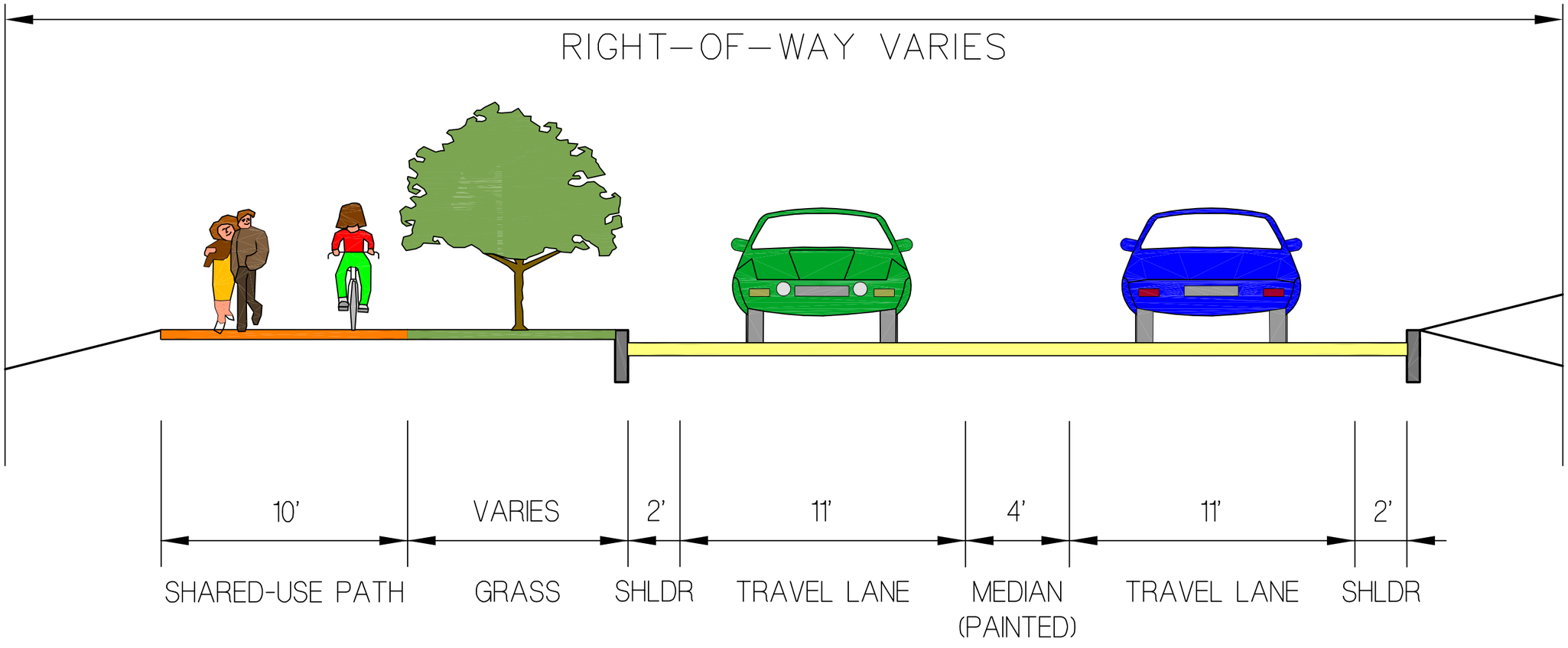
3.2 INTERSECTION IMPROVEMENTS

In addition to modifications to the roadway cross-section and minor geometric adjustments previously discusse, other improvements were also evaluated at intersections within the study area. These included minor modifications in intersection geometry to reduce the paved width of the intersection and improve sight lines, and the potential for installation of traffic signals.

The Manual on Uniform Traffic Control Devices (MUTCD) contains eight warrants for the installation of traffic signals. These warrants, which consider factors such as vehicular and pedestrian volumes, delay and accident history, are listed and described below:

Warrant 1, Eight-Hour Vehicular Volume

For each of any eight hours of an average day, the total number of vehicles from both approaches on the major street and the number of vehicles from one approach on the minor street must meet minimum vehicular volumes.



Schematic Diagram: Not to Scale

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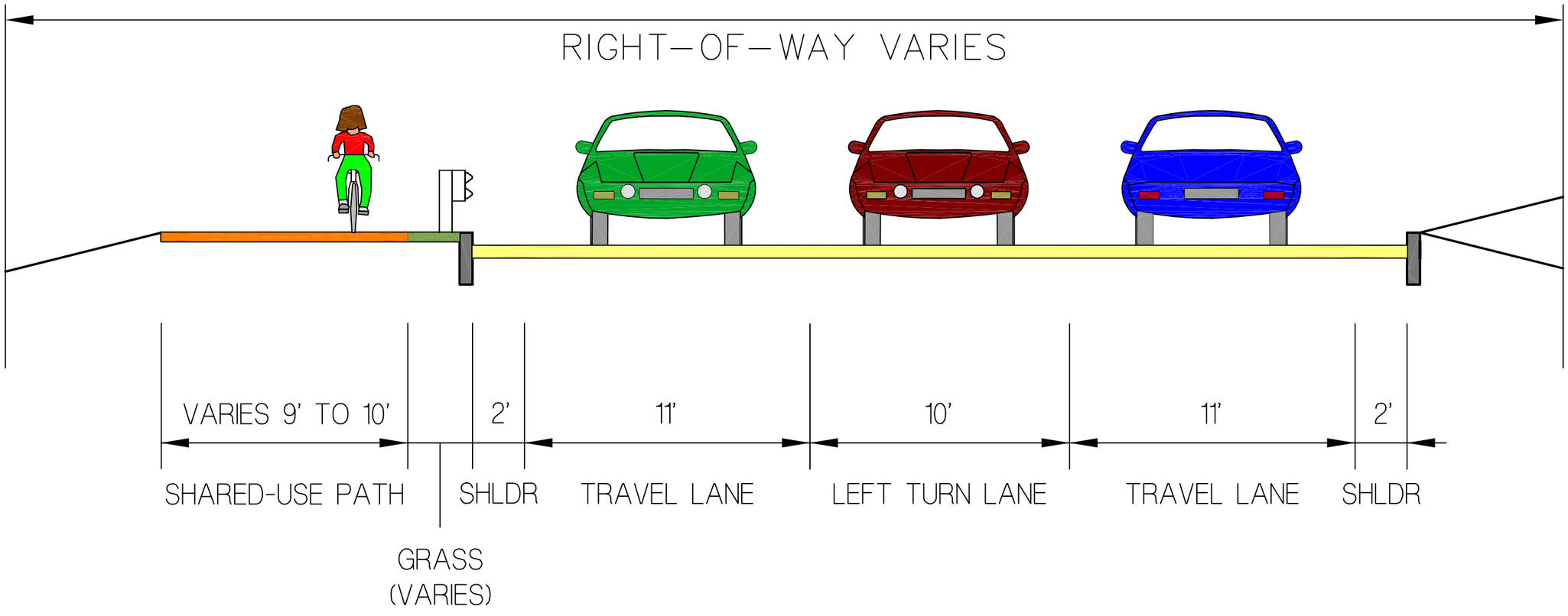
Nonantum Road Improvements
City of Newton and Town of Watertown, Massachusetts
Alternative 2
Typical Roadway Section

Figure 8

dcr



Schematic Diagram: Not to Scale

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City of Newton and Town of Watertown, Massachusetts
Alternative 2
Typical Section at Intersections

Figure 9

dcr

Insert Figure 10

Insert Figure 11

Insert Figure 12

Warrant 2, Four-Hour Vehicular Volume

For each of any four hours of an average day, the plotted points representing the total number of vehicles from both approaches on the major street and the number of vehicles from one approach on the minor street must fall above the appropriate curve.

Warrant 3, Peak Hour

For any one hour of an average day, the plotted points representing total number of vehicles from both approaches on the major street and the number of vehicles from one approach of the minor street must fall above the appropriate curve.

Warrant 4, Pedestrian Volume

Pedestrian volume crossing the major street during an average day is 100 or more for each of any four hours, or 190 or more for any one hour, and there are fewer than 60 gaps per hour in the traffic stream to allow pedestrians to cross.

Warrant 5, School Crossing

The number of adequate gaps in the traffic stream during the period when students are using the crossing is less than the number of minutes in the same period and there are a minimum of 20 students during the highest crossing hour.

Warrant 6, Coordinated Signal System

Adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.

Warrant 7, Crash Experience

Five or more crashes, of types conducive to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage; and for each of any eight hours of an average day, the vehicles per hour given in both of the 80 percent columns of Condition A, or the vehicles per hour in both of the 80 percent columns of Condition B, exist on the major street and the higher-volume minor street.

Warrant 8, Roadway Network

The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and is part of the street or highway system that serves as the principal roadway network for through traffic flow.

An intersection need satisfy only one of these warrants in order for a traffic signal to be considered. However, satisfying one (or more) of these warrants does not in and of itself require either the installation or the continued operation of a traffic signal. A summary of the satisfaction of warrants for the three unsignalized Nonantum Road intersections in this study – at Charlesbank Road, Maple Street, and Water Street – is given in Table 6 (supporting data for these determinations can be found in the Appendix).

As the results of the warrant analysis presented in Table 6 indicate, only the intersection of Charlesbank Road and Nonantum Road handles traffic volumes that exceed any of the signal warrant thresholds. However, the volume on Charlesbank Road approaching the intersection is

almost exclusively right-turning traffic. If it is determined that these right turns do not have a high degree of conflict with traffic on the major street, then this volume should not be considered in the evaluation of signal warrants. In reducing the number of travel lanes on Nonantum Road to one in each direction, it is possible to provide two eastbound lanes past Charlesbank Road. This effectively adds a lane for traffic turning right from Charlesbank Road onto Nonantum Road, basically removing almost any conflict with eastbound traffic on the major road. Therefore, in providing a second eastbound through lane on Nonantum Road east of Charlesbank Road, the approach volume considered as part of the warrant analysis can be reduced and, as a result, installation of traffic signal would not be warranted.

Table 6
Traffic Signal Warrant Summary

Warrant		Warrant Satisfaction (Yes or No)		
No.	Type	Charlesbank Road	Maple Street	Water Street
1	Eight-Hour Vehicular Volume	Yes	No	No
2	Four-Hour Vehicular Volume	Yes	No	No
3	Peak Hour	Yes	No	No
4	Pedestrian Volume	No	No	No
5	School Crossing	No	No	No
6	Coordinated Signal System	No	No	No
7	Crash Experience	Yes	No	No
8	Roadway Network	No	No	No

Table 7
2016 Build Levels of Service (LOS)

	AM Peak			PM Peak		
Movement	Delay[1]	LOS	Queue[2]	Delay	LOS	Queue
Nonantum Road at Charlesbank Road (unsignalized)						
Nonantum WB Lt	14.8	B	100	61.0	F	550
Charlesbank NB Lt/Rt	36.8	E	359	15.2	C	122
Nonantum Road at Maple Street (unsignalized)						
Nonantum WB Lt	8.8	A	4	9.3	A	17
Maple NB Lt/Rt	17.8	C	60	13.8	B	23
Nonantum Road at Water Street (unsignalized)						
Nonantum WB Lt	8.5	A	1	8.3	A	0
Water NB Lt/Rt	13.7	B	13	21.3	C	40

1. Control Delay in seconds per vehicle
2. 95th percentile queue in feet per lane